REMARKS/ARGUMENTS

In response to the request for a complete listing of prior art cited in the parent application 09/628,929, there is attached a Supplemental Disclosure Statement, listing this art. Further, applicant encloses a further copy of the previously submitted Information Disclosure Statement form, as the Examiner had not initialed the entry for the Japanese document. The Examiner is requested to initial the entry for Japanese Application No. JP 08-106913 and return a signed or initialed copy to the undersigned. With respect to the amendments to the specification, it is submitted that most of these are, on their face, clearly concerned with minor clerical or editorial matters. The reference number 24 has been corrected to 44 and the reference number 132, at the relevant location, is being corrected to 131.

The inserted passages concern reference numbers 78, 80, 82, 84, 86, and 88 dealing with details of the steam supply line. All these components are shown using standard symbols, and the inserted passages merely uses the standard names or labels for these components as shown by their symbols in Figure 7. Similarly, components 96, 98, 100 and 102 already shown in Figure 7 using standard schematic representations are now described in the disclosure. Components 112a, 114a are the supply line and steam injector for the oxidant, directly paralleling the supply line 112 and injection 114 for the fuel gas, towards the top of Figure 7. No new matter has been added.

Turning to the claims, as clearly shown in the claims, claims 2, 3 and 6 are being deleted, and the subject matter of these claims has, in effect, been introduced into claim 1. The dependency of claims 4, 7 and 9 has been revised as a result.

A new claim 10 has been introduced directed to the feature of providing a parallel arrangement for a second, process gas stream, as fuel cells usually have two

supply lines, one for a fuel gas stream and one for an oxidant gas stream. Dependent claims 11, 12 and 13 introduce further aspects of these supply lines.

Claim 14 and its dependent claim 15 is directed to an apparatus including a humidification arrangement for a fuel gas stream and a second humidification arrangement for an oxidant gas stream.

The Examiner had rejected claims 1, 2, 3, 6, 7 and 9 under 35 USC 102(b) as anticipated by or, in the alternative, under 35 USC 103(a) as obvious over numerous of the cited references, including four U.S. patents and four Japanese references.

The analysis of the prior art is respectfully traversed, and the Examiner is directed to the detailed review of these references below. In many instances, these features are simply not found in the references. Firstly, it is noted that all of these references are concerned generally with air conditioning systems or the like. None of these references is concerned specifically with the problem of providing humidified process gas to a fuel cell stack. Thus, none of these references specifically address the problem of humidifying a fuel gas, such as hydrogen; nor do any of these references address the problem of the very tight requirements required, for fuel cells, in terms of precise control on humidity and temperature. For air conditioning systems, while some element of control is provided, in general, the volumes of gases involved are many orders of magnitude higher and tolerances on temperature and humidity are much greater, i.e. it is not necessary to have air for air condition spaces maintained within very tight tolerances of humidity and temperature.

More significantly, air conditioning systems generally do not need rapid response times, and indeed the actual time for an air conditioning system to respond to a change in, for example, a temperature setting, is usually not of major concern. If an air conditioning system is of adequate capacity for a building, then this almost necessarily means that its response time will be adequate. Additionally, the basic requirement for an

air conditioning system is that it maintain a uniform temperature and humidity level, and it is not necessary for it to track, for example, constantly changing demands in terms of temperature and humidity.

In contrast, in a fuel cell environment, the demands for a humidification unit are extreme. The flow rates of the gases can vary by orders of magnitude, depending upon the power demands on the fuel cell stack. For example, in automotive or vehicular applications, the power demanded over a fuel cell stack can vary rapidly, depending upon whether a vehicle is accelerating, braking, etc. All of this translates into rapid changes in the flow rates required of the gases powering the fuel cell. In turn, humidification systems must be capable of equally rapid response. Also, due to the unique nature of fuel cells, the actual temperature and humidity requirements for the process gases can also change rapidly. Thus, the sort of arrangement found commonly in air conditioning systems with large chambers, cooling coils, sprayed water and the like are wholly unsuited to fuel cell environments. Due to the large volumes present, the response times would be exceedingly slow and totally unacceptable.

It is noteworthy that all of these references generally use some crude, simple technique to achieve humidification. Thus, the technique of spraying water through moving air is found in many of the references.

The Examiner cited Japanese reference 5-256468, for disclosing a steam generator 24. This disclosure, like many others, is concerned with supply of air that is clean and humidified. As such, like others references generally concerned with air conditioning, it is concerned with delivering large volumes of air at a relatively constant rate, with the temperature and humidity levels maintained essentially constant.

In the translation of the specification as a whole, the component 24 is indeed identified as a "steam generator". As the Examiner is aware, this is a machine translation, and it is noteworthy that it commences with the notice "Japan Patent Office

is not responsible to any damages caused by use of this translation", i.e. there is no certification as to the accuracy of this translation. The abstract identifies the component 24 as a "water-vapor generator", and water vapor is not the same as steam.

It is further noted that component 20 is identified as some sort of tank or chamber in which air is intended to mix with the water-vapor. The provision of a substantially sized chamber or tank would introduce a large dead volume, and again be totally contrary to any requirement to a rapid response time.

In contrast, what the present invention provides is, for each of the oxidant and fuel gas lines, a steam injector, so that the steam is injected directly into the gas flow, without requiring the presence of any large volumes. This enables the flow rate of the steam to be controlled, to match the flow rate necessary for the accompanied gas flow rate.

Turning to the other references, as the Examiner has not reviewed all of these in detail, no detailed comment is made on all of the individual references. The Weitman reference, for example, discloses an apparatus for treating so called contaminated gas, more particularly contaminated air. To this end, it provides a first stage 1 acting as combined heat exchanger and scrubber. A heat exchange coil or the like 5 is provided, which is stated to be for either transferring heat to or from the air (column 3, lines 62 and 63). The injection means 6 sprays a scrubbing liquid onto the contact surfaces 5, to enhance the vaporization of the injected water while binding impurities entering with the air (column 3, lines 66 to column 4, line 1).

The air then passes over a temperature sensor 12 that controls a control valve 13 to control the supply of heat exchange fluid to the first stage. Correspondingly, a sensor 14 controls the supply of heat exchange fluid to heat transfer surfaces 11 in a second stage 2 of the apparatus. Note that the surfaces 11 are intended to be heated, so as to heat the air (column 4, lines 37 and 38).

Consequently, this Weitman proposal lacks many of the elements of the present invention. It provides no equivalent to the separate step (a) of humidifying the process gas stream to the first temperature, and a separate step (b) of the present invention, cooling the process gas stream to second temperature lower than the first temperature to cause condensation of excess moisture. Rather, humidification is done, in an apparently uncontrolled fashion in the first stage. While the second stage 2 may provide some equivalents to heating the gas to a higher temperature, in view of the fact that the absolute humidity of the gas entering the second stage is neither known nor monitored, this proposal provides a system that falls well short of the requirements for precise temperature and humidity control in a fuel cell environment.

With respect to the Japanese reference 56-119434, this is concerned again with conditioning room air. As such, the air first passes through a water spraying cyclone, then passes through a mist spraying cyclone where it is stated that the air is supersaturated and water is removed. The air then flows through a water drop removal cyclone 30 and to a temperature controlling cyclone 101, where the air is apparently reheated.

Again, what is missing here is any stage where the air is subject to any specific cooling step, after the air has been humidified with moisture. The assumption in this proposal is that the two, first cyclones 6, 20 would cause the water to be supersaturated, and indeed such an effect is claimed. In contrast, what the present invention does is to assume that any humidification step will, likely, not produce complete saturation of the gas, so that the absolute humidity level can never be known with any degree of precision. Accordingly, the present invention then cools the process gas, to a certain temperature so that the exact relative humidity level is then known. Such a technique is nowhere taught in this Japanese reference.

In a fuel cell environment, a fuel cell must be capable of responding rapidly to changes in load on a fuel cell, which in turn can be rapid, large and unpredictable.

During start up and shut down, humidity levels must be controlled to ensure that there is no flooding, particularly on start up and also that the fuel cell is not allowed to dry out. If the fuel cell becomes too dry, then the internal membrane of a proton exchange membrane (PEM) fuel cell can become damaged. Moreover, it is commonly required to provide different relative humidity levels, depending upon current densities, temperature of the fuel cell and other factors. Thus, regulating temperature and humidity of fuel cell process gases represents problems quite different from those addressed in the cited references.

A fuel cell system must be capable of responding rapidly and accurately to abrupt changes in load. Temperature and humidity levels may have to be changed in a matter of minutes or seconds, to new and accurate levels. Such stringent requirements are simply not required or taught in the air conditioning art.

In the context of a system for supplying process gases to a fuel cell, steam injection provides a number of advantages, which are nowhere taught or suggested in the art. The following advantages can be noted,

(1) ability to rapidly humidify process gas in a small space and at a high velocity, while avoiding formation of a two-phase mixture;

(2) process piping can be simpler and space requirements much smaller;

(3) it gives a low thermal response, and there is no necessity for significant heat transfer from the process gas to water, in the liquid state, to vaporize the water – in fact, high temperature steam can heat the air;

(4) it enables precise control of humidity;

(5) the present invention is applicable not just to ambient pressure systems, but to pressurized fuel cell systems, and pressurized systems are nowhere addressed in any of the cited art (pressurized systems can operate, for example, at up to 50 psi gauge);

(6) the present invention controls the temperature of the gas at 2 points, namely when the steam is injected, and when the gas is cooled to condense out excess moisture; optionally, the gas temperature can be controlled at a third temperature when the gas is reheated to give a desired relative humidity;

The Examiner then cited element 58 of Christensen as being relevant with respect to claim 6. Element 58 of Christensen is a set of baffles, and it is not seen how this is in any way equivalent to a distinct "separator". Moreover, Christensen, more than most of the art, is concerned with a wholly different environment, namely an apparatus for treating and storing meat. It is submitted that there is absolutely no reason or basis in this art for someone concerned with humidification of a process gas for a fuel cell to consider this Christensen reference. In this context, the Examiner is respectfully referred to MPEP 2143.01 where it is noted that obviousness can only be established "where there is some teaching, suggestion or motivation to do so found explicitly or implicitly in the references themselves or the knowledge generally available to one of ordinary skill in the art".

With respect to claim 7, the Examiner argued that in each of these systems cooling is provided by some sort of conventional heat exchanger (e.g. evaporator) and pump (e.g. compressor) pumping a fluid (e.g. freon) through a circuit.

While this indeed may be present in many of refrigeration circuits, as the Examiner will appreciate, a conventional refrigeration cycle is complex, with the freon being at different pressures in the circuit and constantly switching between vapor and liquid phases.

In contrast, the present invention provides an arrangement where chilled cooling liquid, for example, water, is used as a common source for removing heat from the various heat exchangers. This water would be chilled, typically, by a separate refrigeration circuit. Thus, the cooling circuit for the heat exchangers themselves is relatively simple, and simply requires a supply of the chilled water. As water has a high heat capacity, this can provide efficient heat exchange and compact heat exchangers.

This technique is quite different from that disclosed in the cited references, and again reflects the fact that they are not concerned with a compact piece of equipment capable of rapid response times.

As noted above, it is not believed that Weitman is relevant to the present claims, particularly claim 9, as suggested by the Examiner.

With respect to claims 4 and 5, it is submitted that these claims are allowable both for introducing further patentable features and for being dependent from an allowable claim 1.

With respect to claim 8, the Examiner cited the Oswalt et al. '998 patent. It is submitted that this patent does not disclose a further heater in the sense required by claim 8. In any event, it is submitted that the Examiner has not made out a proper prima facie case for combining Oswalt with the other references, and again Oswalt et al. is concerned with a different area. This patent is concerned with the mechanically

refrigerated chiller system for a process coolant. It is not seen how it would be in any way obvious to combine this reference with the other references cited by the Examiner.

Accordingly, early review and allowance are requested.

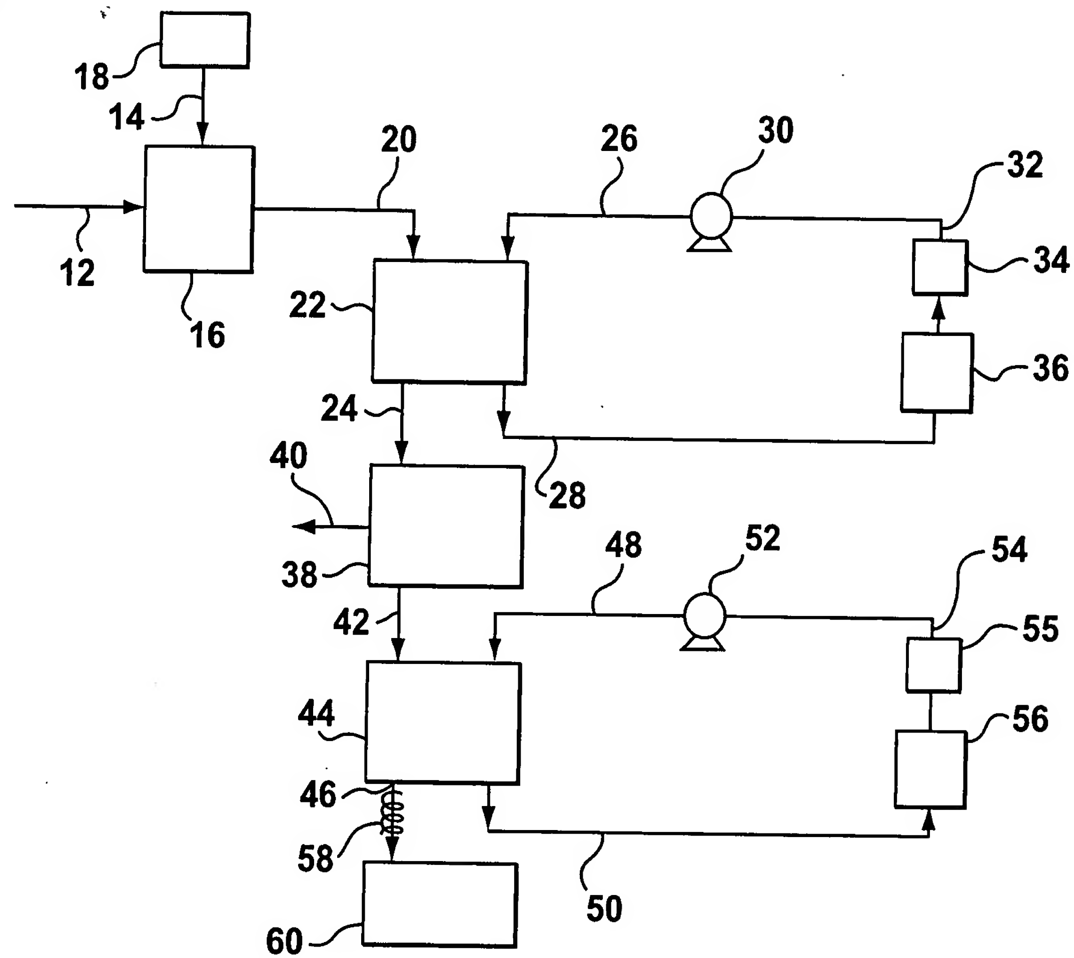
Respectfully submitted,

BERESKIN & PARR

By ______________________

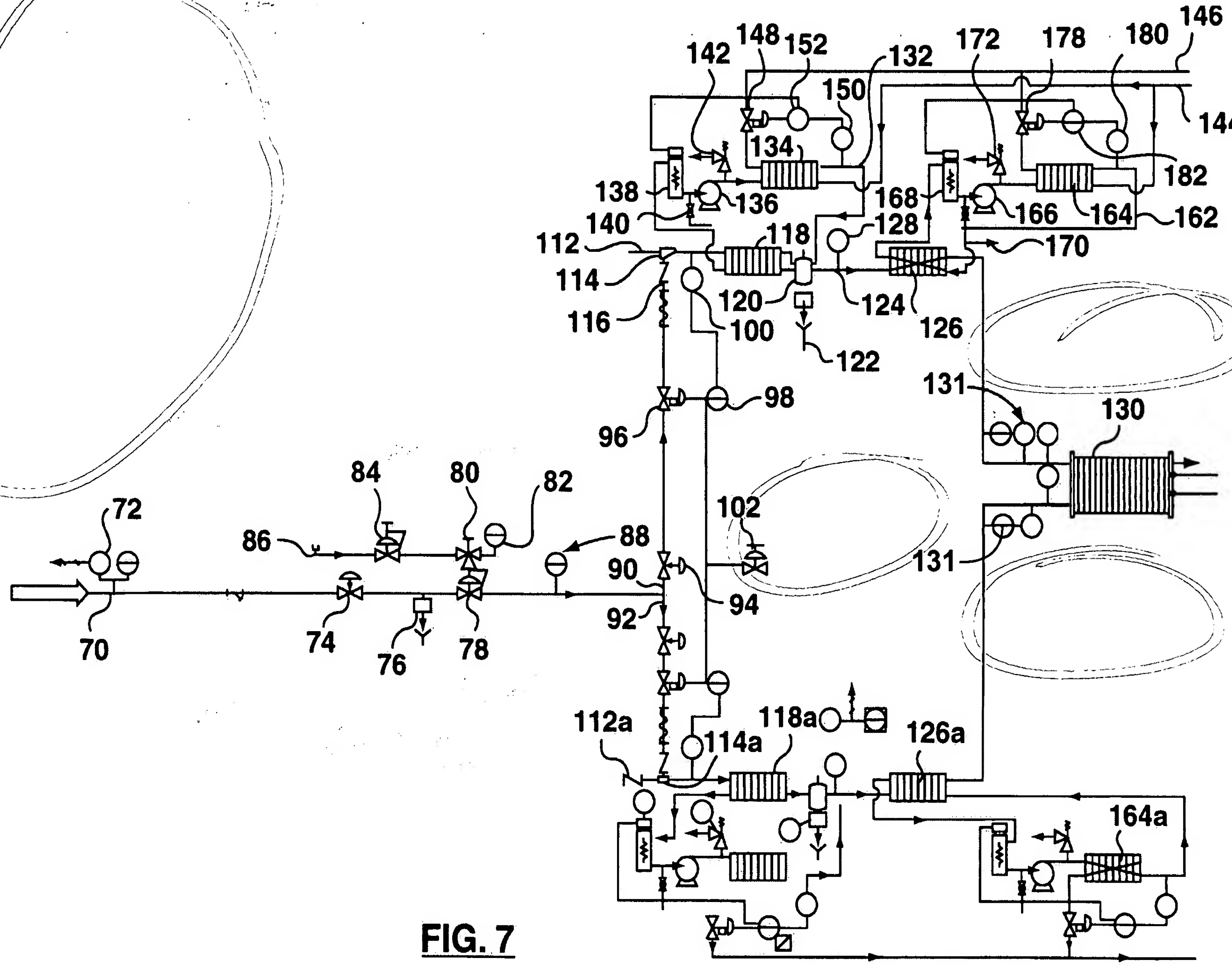
H. Samuel Frost
Reg. No. 31,696
Tel: 416-957-1687

Attachments



12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
55
56
58
60

FIG. 1



70
72
74
76
78
80
82
84
86
88
90
92
94
96
98
100
102
112
114
116
118
120
122
124
126
128
130
131
131
132
134
136
138
140
142
148
152
150
172
178
180
146
144
182
168
166
164
162
170
112a
114a
118a
126a
164a

FIG. 7